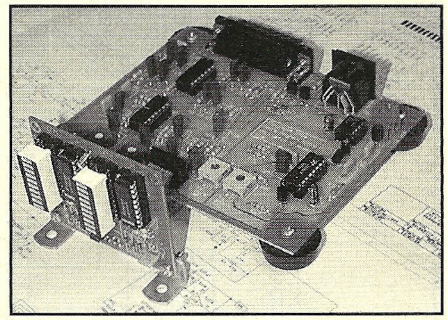
By Terry Mayhan, K7SZL

VolksRTTY II: For RTTY, AMTOR and PACTOR

Part 1—A little-known freeware program and this easy-to-build modem puts you on three HF digital modes at a fraction of the cost of a commercial TNC.



Following publication of the original VolksRTTY article,[1] I was delighted to hear from hams in a number of countries who had successfully built the interface and sampled the digital modes for the first time. There were two common threads to their correspondence. The first was along the lines of "I would have been on RTTY a long time ago if I had known it was going be this easy." The second thread could be paraphrased as "This RTTY is a blast—now how do I get on PACTOR?"

This latter question struck a chord with me since, using *HamComm*, I had been able to monitor PACTOR QSOs (but not transmit) for quite some time and had developed a keen appreciation for just how well the mode works. Unlike RTTY, which forces the operator to accept varying degrees of garbled copy during marginal conditions, PACTOR employs an error-correcting *ARQ* protocol. The concept behind ARQ is that the transmitting station sends a short block of data, then waits for an acknowledgement before continuing. If the receiving station doesn't acknowledge the block, or explicitly replies with a *NAK* (no acknowledgement), the block is automatically retransmitted. Additionally, PACTOR has provisions for automatically shifting the data rate between 100 and 200 bits per second to maximize the information rate during varying propagation conditions. Clearly, PACTOR offers a number of significant advantages for ragchewing and weak-signal DX work. It's also among the most popular of the HF digital modes.

In my quest for a full PACTOR capability, I initially attempted the time-honored strategy of system designers everywhere when faced with a new set of functional requirements: Lay it on the software group. I badgered the developer of *HamComm*, DL5YEC, to add PACTOR transmit to the program for nearly a year without success. Django had just started a major project to develop a *Windows*-based ACARS decoding program and—quite reasonably—wasn't enthusiastic about dropping that project just to satisfy my desire for a PACTOR upgrade. Finally recognizing the futility of this approach, I began looking on the Internet for other programs that might support PACTOR. After an extensive search, I turned up only two candidates: *BMK-Multy* offered by BARTG[2] and *TERMAN93* by Tom Sailor, HB9JNX. By all accounts, *BMK-MULTY* is an excellent piece of software, but at around $200 US for a version that supports RTTY and PACTOR, it was more than I wanted to spend. *TERMAN93*, on the other hand, was available for download[3] at no cost and, therefore, appealed to my cheap uh... frugal nature.

Once I had downloaded and examined *TERMAN93* (hereafter "T93" for brevity), I could see that the project was going to be more difficult than initially anticipated. Unlike *HamComm*, which implements much of the modem functionality in software, T93 requires external hardware to demodulate the AFSK signal from the receiver. Additionally, T93 requires an external phase-continuous oscillator to generate the AFSK tones (or a radio with a direct FSK capability). Finally, T93 needs some sort of indicator to facilitate

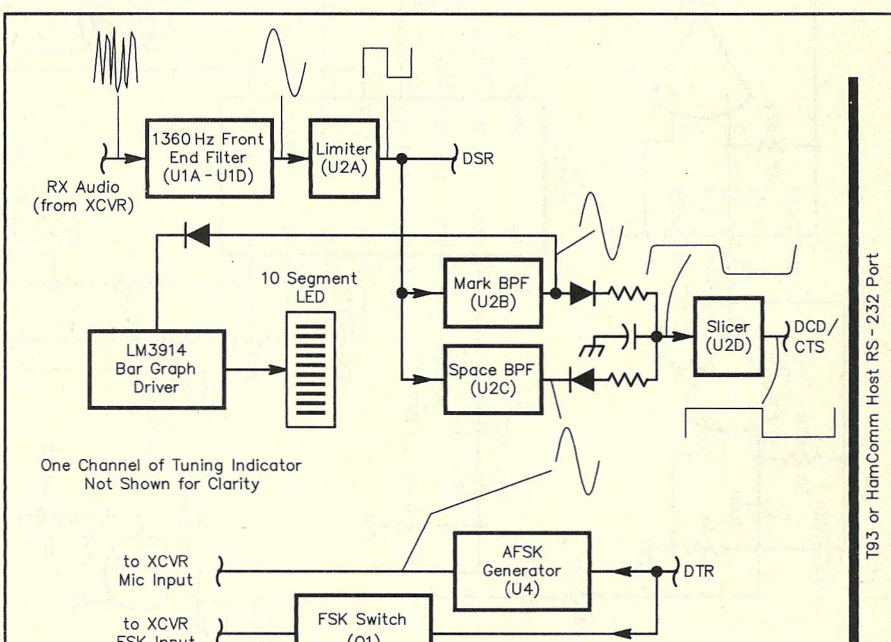


Figure 1—VolksRTTY II block diagram.

[1]Notes appear on page 44.

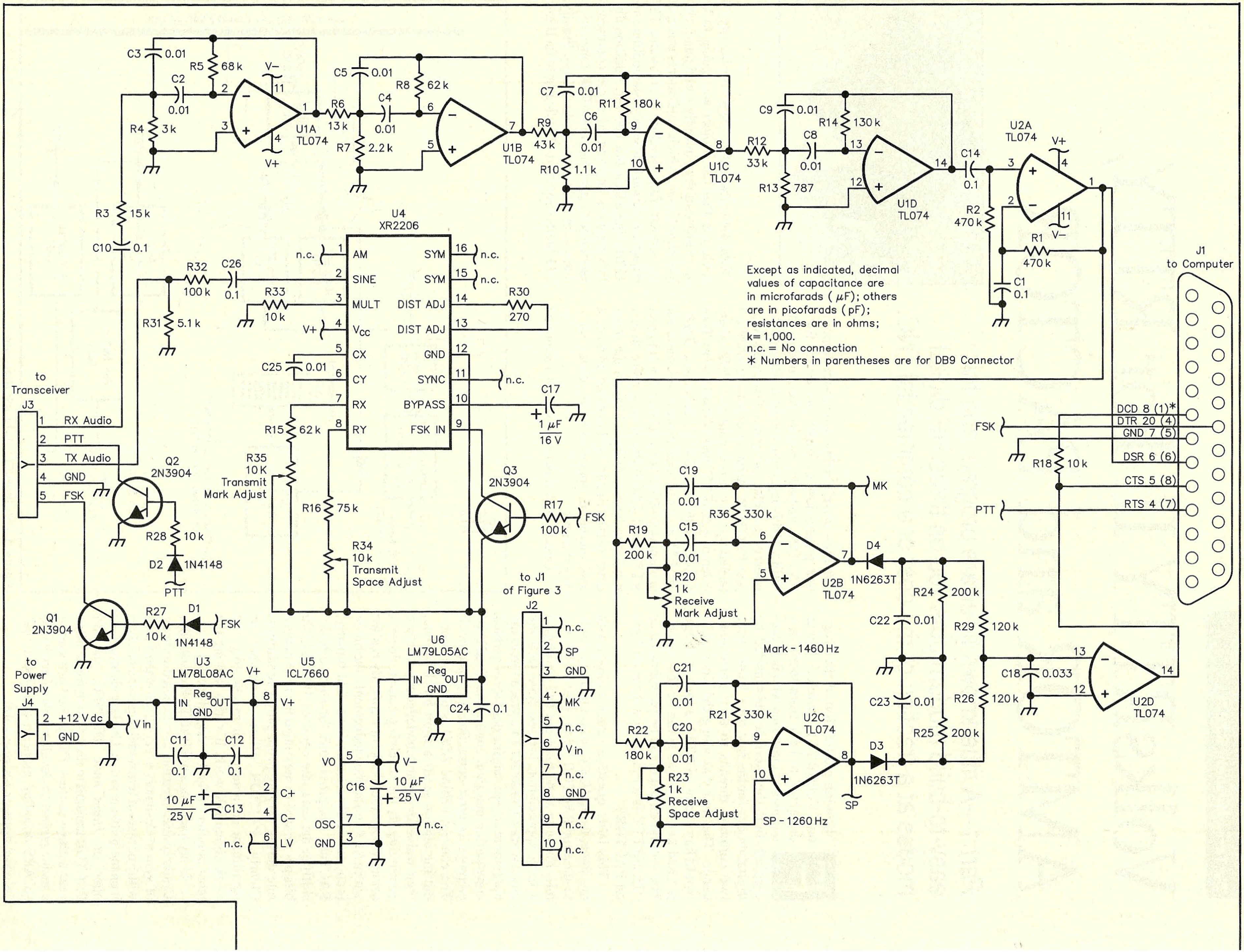

C3 0.01
R5 68k
V−
C2 0.01
R4 3k
U1A TL074
V+
C5 0.01
R8 62k
R6 13k
C4 0.01
R7 2.2k
U1B TL074
C7 0.01
R11 180k
R9 43k
C6 0.01
R10 1.1k
U1C TL074
C9 0.01
R14 130k
R12 33k
C8 0.01
R13 787
U1D TL074
U2A TL074
C14 0.1
R2 470k
R1 470k
C1 0.1
R3 15k
C10 0.1
U4 XR2206
n.c.
AM
SINE
MULT
Vcc
CX
CY
RX
RY
SYM
DIST ADJ
GND
SYNC
BYPASS
FSK IN
R32 100k
C26 0.1
R33 10k
R31 5.1k
R30 270
C25 0.01
C17 1 µF 16 V
to Transceiver
J3
RX Audio
PTT
TX Audio
GND
FSK
Q2 2N3904
R15 62k
R35 10K Transmit Mark Adjust
R28 10k
D2 1N4148
R16 75k
R34 10k Transmit Space Adjust
Q3 2N3904
R17 100k
Q1 2N3904
R27 10k
D1 1N4148
to Power Supply
J4
+12 V dc
Vin
U3 LM78L08AC
Reg IN OUT GND
C11 0.1
C12 0.1
U5 ICL7660
V+
C+
C−
LV
VO
OSC
GND
C13 10 µF 25 V
U6 LM79L05AC
C24 0.1
C16 10 µF 25 V
to J1 of Figure 3
J2
n.c.
SP
GND
MK
Vin
Except as indicated, decimal values of capacitance are in microfarads (µF); others are in picofarads (pF); resistances are in ohms; k= 1,000.
n.c. = No connection
* Numbers in parentheses are for DB9 Connector
J1 to Computer
DCD 8 (1)*
DTR 20 (4)
GND 7 (5)
DSR 6 (6)
CTS 5 (8)
RTS 4 (7)
R18 10k
C19 0.01
R36 330k
R19 200k
C15 0.01
R20 1k Receive Mark Adjust
U2B TL074
D4 1N6263T
Mark - 1460 Hz
R24 200k
R29 120k
C22 0.01
C18 0.033
R26 120k
C23 0.01
R25 200k
U2D TL074
C21 0.01
R21 330k
U2C TL074
R22 180k
C20 0.01
R23 1k Receive Space Adjust
D3 1N6263T
SP - 1260 Hz

Figure 2—Schematic of the main circuit board. Unless otherwise specified, use ¼ W, 5%-tolerance carbon composition or film resistors. Equivalent parts may be substituted for those shown. Percent values indicate part tolerances. See the "Part Suppliers" sidebar for contact information.

C1, C10-C12, C14, C24, C26—0.1 µF, 10% (Jameco P/N 25523)
C2-C9—0.01 µF, 2% (Mouser P/N 140-PF2A103F)
C13, C16—10 µF, 16 V (Jameco P/N 94211)
C15, C19-C23, C25—0.01 µF, 5% (Mouser P/N 140-PF2A103J)
C17—1 µF, 50 V (Jameco P/N 29831)
C18—0.033 µF, 5% (Mouser P/N 140-PF2A333F)
D1, D2—1N4148 (Jameco P/N 36038)
D3, D4—1N6263T (Future Active P/N 101-1570)
J1—DB25 Female (Jameco P/N 15181)
J2—Header, 10 pin (Jameco P/N 67820)
J3—DIN-5 (PC mount, Jameco P/N 29399)
J4—Terminal block (Jameco P/N 152346)
Q1, Q2, Q3—2N3904 (Jameco P/N 38359)
R1, R2—470 kΩ
R3—15 kΩ
R4—3 kΩ
R5—68 kΩ
R6—13 kΩ
R7—2.2 kΩ
R8, R15—62 kΩ
R9—43 kΩ
R10—1.1 kΩ
R11, R22—180 kΩ
R12—33 kΩ
R13—787 Ω, 1%
R14—130 kΩ
R16—75 kΩ
R17, R32—100 kΩ
R18, R27, R28, R33—10 kΩ
R19, R24, R25—200 kΩ
R20, R23—1 kΩ pot, PC mount (Jameco P/N 42964)
R21, R36—330 kΩ
R26, R29—120 kΩ
R30—270 Ω
R31—5.1 kΩ
R34, R35—10 kΩ pot, PC mount (Jameco P/N 43001)
U1, U2—TL074 (Jameco P/N 33216)
U3—LM78L08 (Mouser P/N 333-ML78L08A)
U4—XR2206 (Jameco P/N 34972)
U5—7660 (Jameco P/N 51174)
U6—LM79L05 (Jameco P/N 51422)
14-pin DIP socket (Jameco P/N 112213)
16-pin DIP socket (Jameco P/N 112221)
8-pin DIP socket (Jameco P/N 112205)

tuning the receiver for correct mark/space tone frequencies. In short, the program requires a modem—what old timers would refer to as a *terminal unit* (TU).

At this point, the dimensions of the project were beginning to take shape, and I established the following design objectives for the second-generation VolksRTTY:

1. It should be compatible with both T93 and *HamComm* (including tuning indicators).

2. It should be suitable for construction by any amateur with reasonably well developed homebrew skills.

This latter requirement translates into modest circuit complexity, readily available components and easy alignment without special test equipment. Decide for yourself whether VolksRTTY II (or VR2) meets these design goals.

Circuit Description

Referring to the block diagram in Figure 1 and the circuit schematics (Figures 2 and 3), readers who are familiar with the FM-based terminal-unit designs of the '60s and '70s will immediately recognize the roots of VR2. Active filters have replaced LC filters, and integrated circuits are used in lieu of discrete transistors (or tubes), but otherwise VR2's architecture is essentially identical to those earlier designs. The circuit is comprised of six functional elements: front-end bandpass filter; limiter; FSK demodulator; AFSK generator; tuning indicator and power supply. Let's examine the operation of each before proceeding with the construction details.

Front-End Filter

The purpose of the front-end filter is to improve the signal-to-noise ratio of the AFSK tones prior to limiting—this greatly increases the likelihood that the desired signal (and not QRM) will capture the limiter. A quad TL074 op amp (U1A through U1D) comprises an active Butterworth bandpass filter with a center frequency of 1360 Hz. This frequency was selected to comply with the European digital-tone standard supported by most modern transceivers. The lower tone frequencies of the European standard make it easier to obtain good filter skirt selectivity than with the US standard (nominally 2110 Hz). The resonant frequencies of each filter stage are staggered, and the Qs have been selected to provide a response that is 500 Hz wide at the –3-dB points. This filter is about as narrow as it can be without "smearing" a 200-baud PACTOR signal and causing a copy-destroying phenomenon called *intersymbol interference* (ISI). For RTTY, this filter is twice the necessary bandwidth, causing the modem to incur a 3-dB performance penalty. A switched, two-stage filter scheme was considered and rejected in favor of circuit simplicity and ease of implementation, however, such an enhancement could easily be added to the modem.

Limiter

The filtered signal is then applied to a limiter (U2A) that helps maintain a constant mark and space signal amplitude in the presence of selective fading. Up to this point, the circuit is functionally identical to the VolksRTTY *HamComm* interface. This is intentional, since one of the design objectives for the VR2 was to support all of *HamComm*'s functions, including its superb software tuning indicators. Note that the filtered and limited audio output from U2A is applied to the RS-232 DSR line (pin 6 of J1), which *HamComm* uses for its spectral-display input.

FSK Demodulator

Following "squaring up" by the limiter, the AFSK signal is applied to two parallel, 100-Hz wide band-pass filters (U2B and U2C), one of which is tuned to the mark frequency and the other to the space frequency. The outputs of the mark and space filters are rectified, summed with opposite polarity (D3 and D4) and filtered (C22, C23, R24, R25, R26, R29, C18) to remove the audio carrier and other noise. Collectively, these components comprise a frequency-to-voltage converter. The summed and filtered signal is then input to limiter U2D (also know as a *slicer*), which digitizes the waveform and converts it to an RS-232-compatible level. The output of U2D represents the demodulated baseband data signal and is applied to two pins (DCD and CTS) on J1 to accommodate the external converter input requirements for both *HamComm* and T93.

AFSK Generator

An XR2206 (U4) serves as a phase-continuous oscillator to generate the mark and space tones for modulating a transceiver in SSB mode. Depending upon the FSK state (ie, mark or space) commanded by the host, one of two pots (R34 or R35) is selected by U4. In conjunction with C26, the selected pot establishes the mark or space tone frequency. Resistors R31 and R32 serve as a voltage divider to reduce the AFSK level to a value suitable for direct input to the mike connector of the transceiver. FSK operation is also supported with an open-collector transistor switch (Q1). While not a part of the AFSK generator per se, it is worth noting that another open-collector switch (Q2) serves to ground the transceiver's PTT line during transmitting.

Tuning Indicator

Tuning indication is provided by separately rectifying the outputs from the mark and space filters and applying each to an LM3914 bar-graph display driver. The LM3914 is a form of analog-to-digital converter. It has 10 discrete inputs, each of which can sink a constant current from one element of a 10-segment LED bar-graph display. At low input voltages, the driver illuminates the LED segment at one end of the display by activating the current sink associated with that segment. As the input level increases, the driver switches the active current sink to move the illuminated segment toward the opposite end of the display. Consequently, the displacement of the illuminated segment is proportional to the input voltage.

The levels of the rectified mark and space filter outputs and the sensitivity of the LM3914 are such that—when a signal is exactly tuned in—the position of the illuminated LED segment is at the extreme end of the display. In the absence of an AFSK signal, random noise is sufficient to drive the tuning indicators to relatively high lev-

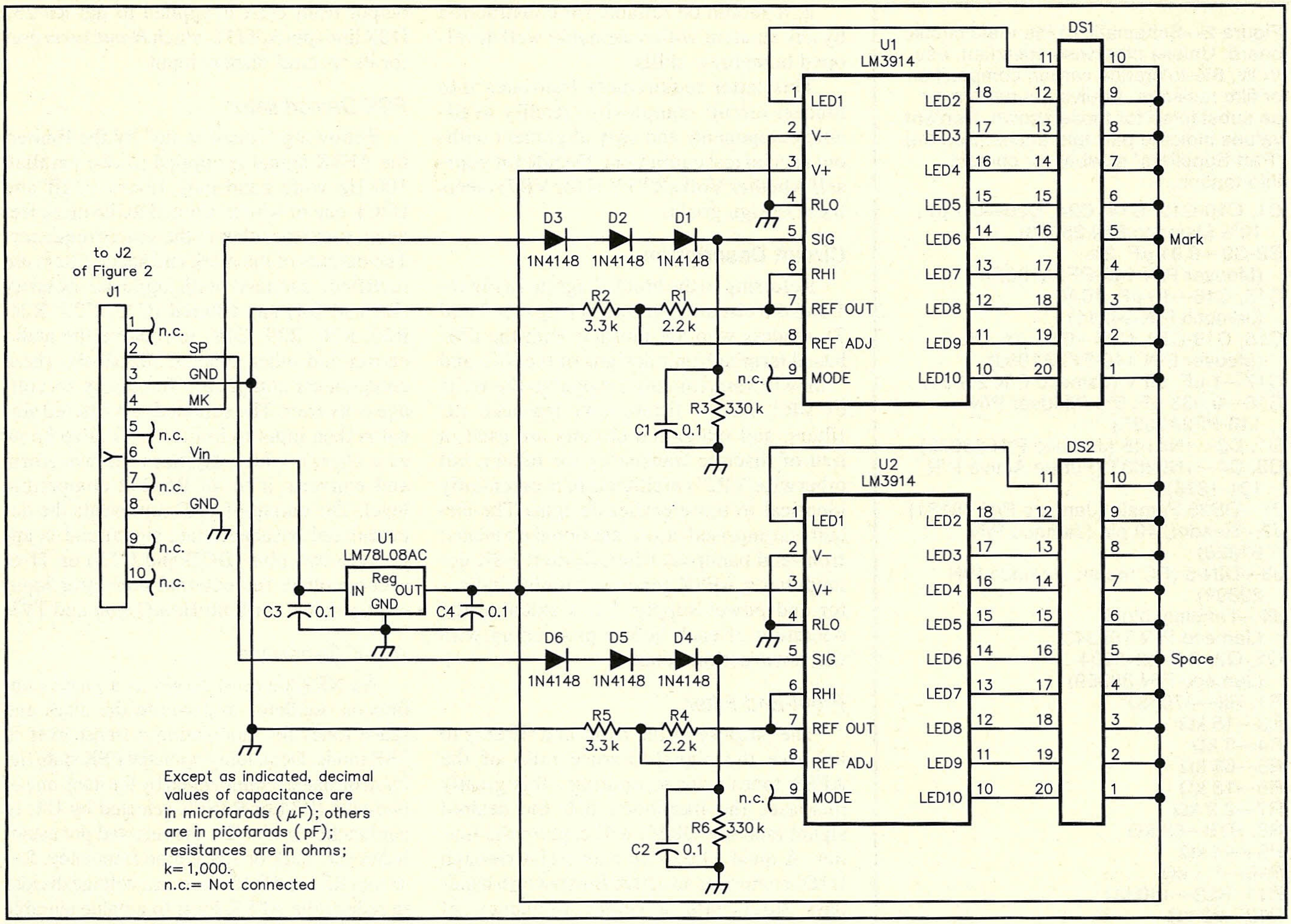


Figure 3—Schematic of display board. Unless otherwise specified, use 1/4 W, 5%-tolerance carbon composition or film resistors. Equivalent parts may be substituted for those shown. Percent values indicate part tolerances. See the "Part Suppliers" sidebar for contact information. J1 connects to J2 of Figure 2 via a six-inch 10-conductor ribbon cable with 10-pin IDC connectors (Jameco P/N 138376) at each end.

C1-C4—0.1 µF, 10% (Jameco P/N 25523)
D1-D6—1N4148 (Jameco P/N 36038)
DS1, DS21—Bar graph (Mouser P/N 512-MV57164)
J1—Header, 10 pin (Jameco P/N 67820)
R1, R4—2.2 kΩ
R2, R5—3.3 kΩ
R3, R6—330 kΩ
U1, U2—LM3914 (Jameco P/N 24230)
U3—78L08 (Mouser P/N 333-ML78L08A)
18-pin DIP socket (Jameco P/N 112230)
20-pin DIP socket (Jameco P/N 112248)

Parts Suppiers

Jameco Electronic Components
1355 Shoreway Rd
Belmont, CA 94002-4100
tel 800 831-4242
fax 800 237-6948
http://www.jameco.com
info@jameco.com

Future Active, Dept FAC 7
41 Main St
Bolton, MA 01740
tel 800 655-0006
fax 800 645-2953
http://www.future-active.com
catalogsales@future.ca

Mouser Electronics
958 N Main St
Mansfield, TX 76063-4827
tel 800 346-6873
fax 817 483-0931
http://www.mouser.com
sales@mouser.com

els. To compensate for this, and to provide a threshold effect, three diodes are series connected in each channel. The sum of the diode voltage drops causes the display to indicate an intermediate level in the absence of an in-band FSK signal.

Power Supply

Unlike the original VolksRTTY interface that derived its power from the host computer's RS-232 port, VR2 requires an external dc power source of at least 100 mA. It's best to keep the power supply voltage between 11 and 14 V. Higher input voltages can be used, but some of the regulators on the main and display boards will run quite warm to the touch. The power-supply voltage is initially dropped to 8 V dc using an LM78L08 linear regulator. The output of the regulator provides the positive rail voltage for the modem as well as the input to the '7660 dc-to-dc converter that provides –8 V dc for the negative rail. Regulator U6 cleans up switching noise on that rail to ensure that the power supplied to the AFSK oscillator (U4) is clean.

Next Month

Using Figures 2 and 3, you can procure the parts.[4] Next month, Part 2 will describe construction of the modem and operation of the system.

Notes

[1]T. Mayhan, K7SZL, "VolksRTTY—An Improved *HamComm* Interface," *QST*, April 1998, pp 46-50.

[2]See the British Amateur Radio Teledata Group (BARTG) Web page at **http://www.bartg.demon.co.uk/Sales/software.htm** for details and ordering information.

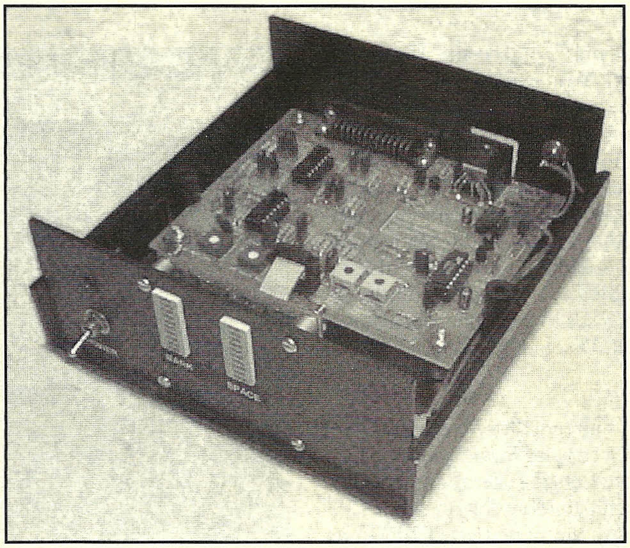
[3]You can download the latest version of *Terman93* at **http://www.ife.ee.ethz.ch/~sailer/ham/ham.html#hfterm**; Look for Terman93.zip.

[4]A limited number of VR2 parts kits are available from the author for $80 each, plus $5 for US shipping ($10 for overseas). The kit includes main and display PC boards, all board-mounted components and interconnecting ribbon cable. Order from Terry Mayhan, K7SZL, 4517 159th AVE NE, Redmond, WA 98052; **tmayhan@worldnet.att.net**; **http://home.att.net/~k7szl/**.

By Terry Mayhan, K7SZL

VolksRTTY II: for RTTY, AMTOR and PACTOR

Part 2—Let's construct the modem and put it on the air.



Part 1 of this article describes the circuit and its operation, presents the schematics, part lists and software sources.[1] Refer to Part 1 as we construct the modem and put the system on the air.

Construction

VolksRtty II can be built on a PC board or perfboard with point-to-point wiring—neither lead length nor component layout is critical. I developed a set of PC boards[2] for my unit: a 4×5-inch main board and a 2×2½-inch display board. All connectors (DB25 for the computer's RS-232 interface, DIN-5 for connecting to the transceiver and a terminal block for power) are mounted on the main PC board so no point-to-point wiring is required. A short ribbon cable carries the mark and space signals, unregulated power and ground from the main to the display board. The size of the display board allows it to be mounted vertically on a relatively small front panel for ease of viewing. In a departure from the PK-232 style of tuning indicator, VR2's displays are oriented vertically, with the segments at the top corresponding to maximum input.

Pay close attention to the values and tolerances of the resistors and capacitors associated with U1A through U1D—use *exactly* the values specified, with 5%-tolerance resistors and 2%-tolerance capacitors or better. These components establish the passband characteristics of the 1360-Hz band-pass filter, which greatly affects the performance of the modem.

The completed circuit boards can be installed in a suitably sized plastic[3] or metal[4] enclosure of your choice. I haven't encountered any RF-intrusion problems with this circuit, but if you intend to run high power or have occasionally experienced RF in your shack, prudence suggests a shielded enclosure.

Checkout and Alignment

Hardware Checks

Before applying power, insert U5 into its socket on the main board. Do *not* install the remaining DIP ICs or the ribbon cable to the display board just yet. Apply power to J4 and confirm that the voltages in Table 1 are present at the indicated locations. (All voltages are measured with respect to ground.)

Disconnect the power supply, install the balance of the ICs on the main board and recheck all voltages with power applied. The +8- and –5-V readings should be identical to the values previously measured, but the –8-V dc rail will normally sag a bit under load (–6.5 to –7.0 V dc). Disconnect the power supply and install the ribbon cable that connects the main and display boards together. With the 10-segment LED displays and the two LM3914s *out* of their sockets, apply power to the main board and measure

[1]Notes appear on page 41.

Table 1
Main Board DC Voltage Readings

	U5		U1		U2		U4	
Pin	8	5	4	11	4	11	4	12
DC Voltage (Only U5 installed)	+8	–8	+8	–8	+8	–8	+8	–5
DC Voltage (All ICs installed)	+8	–6.5 to –7.0	+8	–6.5 to –7.0	+8	–6.5 to –7.0	+8	–5

Table 2
HC31.CFG File Changes for VolksRTTY II

Search for	*Change to*
select port	select port com*x* (where *x* is the number of the COM port you use)
set afcenter	set afcenter 1360
set afshift	set afshift 170 Hz (or 200 Hz*)
set extconv	set extconv on

*Both shifts are commonly found on the HF bands—170 Hz is typically used for RTTY, while PACTOR more frequently uses 200 Hz. Decide which mode you anticipate using most frequently and select the corresponding shift, or even "split the difference."

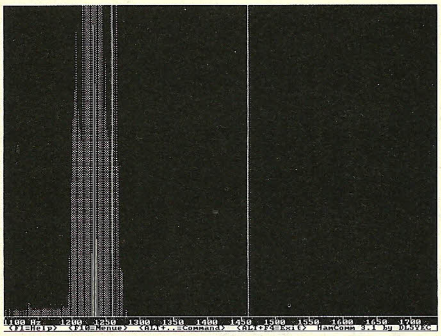


Figure 1—Tuning display showing AFSK space tone before alignment (200-Hz shift).

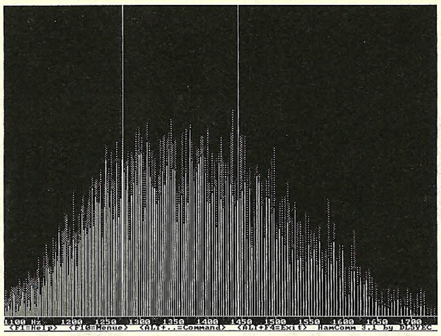


Figure 2—*HamComm* tuning display with no signal present (170-Hz shift).

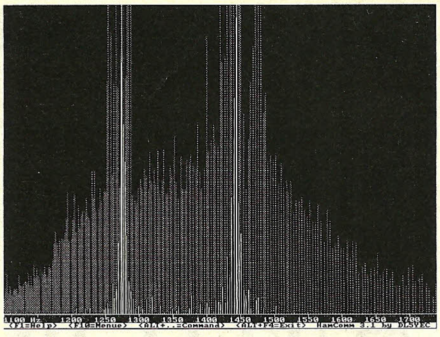


Figure 3—*HamComm* tuning display with properly tuned RTTY signal (170-Hz shift).

the voltage at pin 3 of U1 and U2 on the display board. You should see +8-V dc. Disconnect the power supply and install the indicators and ICs in the display board. Again, pay close attention to orientation. Reapply power to the main board and confirm the absence of smoke, exploding components or other signs of circuit trauma. With no receive-audio input connected to J3, both LED indicators should be dark, although you may see a brief flash when power is first applied. Disconnect the power.

Test Software

If you don't already have it on your hard drive, acquire a copy of *HamComm* V3.1[5]—this will be used during the alignment process, plus it's outstanding for general RTTY operating. Copy the compressed file to an appropriately named subdirectory on your computer's hard drive (eg, C:\HC), and execute it by typing HAMCOM31. The program will extract a number of files and place them in the same subdirectory. These include the executable for *HamComm* (HC.EXE), a configuration file (HC31.CFG) that defines *HamComm*'s operating parameters, and a very extensive documentation file (HC.DOC). Make a backup copy of HC31.CFG, then use your favorite text editor to open HC31.CFG and, at a minimum, make the changes shown in Table 2. The file is very long (about 700 lines), so I've indicated a "search for" text to help locate each parameter in the file. When you have completed the changes, save the file as plain text with the same name (HC31.CFG) and exit.

Alignment

With power removed from the main board, use a standard serial cable to connect J1 on the main board to your computer's RS-232 port. Install a short piece of solid #22 wire as a jumper between the RX-Audio (pin 1) and TX-Audio (pin 3) terminals on J3. The jumper connects the AFSK output of the modem to the received-audio input so that the modem listens to itself. Apply power.

Operating in the native DOS mode,[6] execute *HamComm* by typing HC from the subdirectory containing the *HamComm* files. Press **F7** to switch to the spectrum-

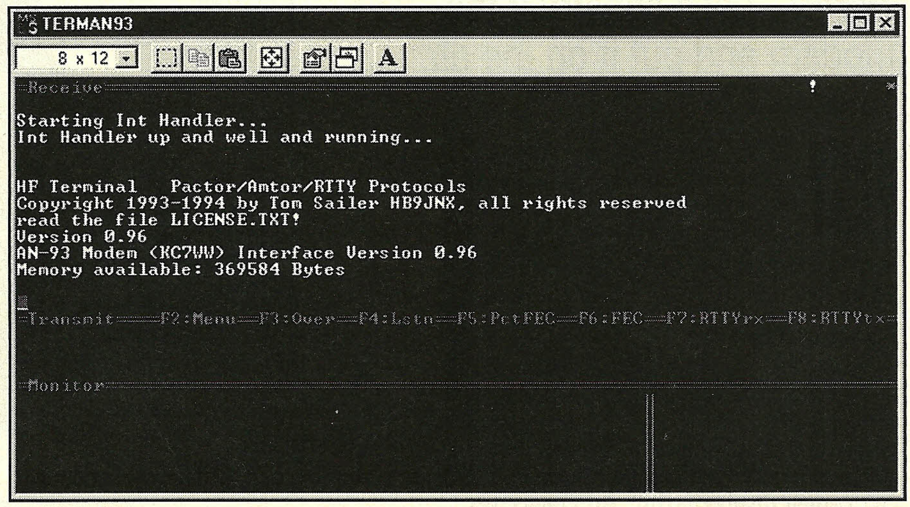


Figure 4—*Terman93* start-up screen.

analyzer display and hit the **PAGE UP** key three times to expand the display scale. You will see two fixed, green "target" tuning lines on the black background. (See Figure 1.) If you selected a 200-Hz shift, one line will be at 1260 Hz and the other at 1460 Hz.

Somewhere near the 1260-Hz line, you should see a bright yellow line that scintillates a bit. That's the signal from the modem's AFSK generator. Using a small screwdriver, adjust the **Transmit-Space-Adjust** control (R34) to set the space frequency of the AFSK generator to exactly coincide with the 1260-Hz target line. Observe DS2—you should see one or two segments illuminated. Now adjust the **Receive-Space-Adjust** control (R23) through its range. Notice that the illuminated segments move to the top end of the display and then retreat. The upper position corresponds to maximum signal. Carefully adjust the control to maximize the reading on display DS2. This completes the alignment of the space channel.

To align the mark channel, use a short clip lead to connect the junction of R17 and Q3 to pin 5 of U5—this switches U4, the AFSK generator, to a mark state. Observe that the yellow line has now shifted to the vicinity of the 1460-Hz target line. Adjust the **Transmit-Mark-Adjust** control (R35) so that the yellow line and the target line exactly coincide. Observe DS1; you should see one or two segments illuminated. Adjust **Receive-Mark-Adjust** control (R20) until the deflection of DS1 is at maximum. This completes the modem hardware adjustments—disconnect the power supply and remove the clip lead and jumper in J3.

Functional Test Drive

At this point, you should have a fully functional modem. Before you load T93 (*Terman93*), let's do a test drive of the modem with *HamComm*—this will provide a good opportunity to become familiar with VR2's tuning indicator since you can compare its appearance with *HamComm*'s on-screen indicators. Connect VR2 to your transceiver's receive-audio, microphone and PTT lines. Receive audio can be obtained by a parallel connection across the speaker or via a plug partially inserted into the headphone jack. Either approach allows you to listen to pitch cues as you tune in FSK signals. The best choice for a microphone-audio, PTT and ground interface is the transceiver's front-panel microphone connector. Many newer transceivers have a digital-interface port, however, they may not be compatible with the VR2 without modifications. For now, stick with a proven approach.

If you later decide to reconnect the modem to your transceiver's digital port for direct FSK operation, don't forget to program the transceiver for a 1360-Hz center frequency.

Set the transceiver to USB and disable the VOX feature. If your transceiver has selectable filters, choose one with a bandwidth between 1.8 and 2.7 kHz. Using a wider filter bandwidth than necessary eliminates the effects of passband tuning on VR2's front-end filter. Later, when you are actually operating RTTY and PACTOR, you will want to select filter bandwidths of 250 and 600 Hz, respectively. At that point, passband tuning becomes a critical parameter, and it must be centered at 1360 Hz. Tune the receiver to a clear frequency. Restart *HamComm*, press **F7** to bring up the spectrum-analyzer tuning screen and hit the **PAGE UP** key three times to expand the display.

Apply power to the modem and slowly increase the receive volume. Observe that, in response to the random noise, VR2's tuning indicators begin to dance at the bottom of the scale. As the volume is increased, the illuminated segments move up the scale until they reach a point where increasing audio levels cause no further deflection. Leave the volume control at this setting and confirm that roughly 60% of each display's segments are illuminated. Compare the *HamComm* tuning screen with Figure 4—the two should be similar. If the two differ significantly, there is probably a trouble with the wiring or components associated with U1.

Set your transceiver to the digital portion of your favorite band and tune the receiver to a reasonably strong RTTY signal. Using the spectrum-analyzer tuning indicator screen, carefully adjust the receiver tuning until the yellow mark/space lines of the RTTY signal are aligned with the green tuning lines as shown in Figure 3.

Observe VR2's LED tuning indicators. Note that as the received signal toggles between mark and space, the two indicators alternate between maximum (within one segment) and minimum. Rock the dial back and forth and note how the displacement of the LEDs changes as the signal is mistuned. Tune in the signal several times, switching your attention between *HamComm*'s tuning display and the one on VR2 until you are confident that you understand what LED pattern to look for on VR2. With the signal properly tuned, press **F3** to return *HamComm* to the RTTY screen. You should see intelligible text being printed. (If you have gotten this far successfully, VR2's front-end filter, limiter and FSK detector are working.)

Connect your transceiver to a dummy load or tune it to a clear frequency in one of the RTTY bands. Adjust your transceiver in the same manner that you would to operate on SSB (USB mode). Reduce the microphone gain to its minimum level. On your keyboard, press the **CONTROL** key with one finger and the **T** key with another. You should hear your transceiver's TR relay pull in, or see signs that the transceiver has switched from receive to transmit mode. At the same time, you should hear the distinctive "diddly, diddly, diddly . . ." of an idling RTTY signal coming from your PC speaker. Slowly increase your microphone gain while observing the plate current (drain or collector current for solid-state rigs). Increase the gain to achieve a reading equal to about one-half of that normal for CW operation. (Since RTTY is a continuous "key on the brick" mode, you don't want to run your radio at more than about one-half power, unless the instruction manual indicates otherwise.) At this half-power level, your mike gain should be around the normal level used for voice. You should not observe much plate (collector) current variation with the different mark/space tones being transmitted as *HamComm* idles. Type in a few characters (like your call sign) followed by a tap on the space bar and observe the change in sound. The transmitted characters will appear, highlighted in gray, on the lower receive window. To stop transmitting and return to the receive mode, you have two options: **CTRL-T** or **CTRL-BACKSPACE**. The former command immediately terminates the transmission, while the latter switches back to receive only after the transmit-buffer contents have been sent. For an exhaustive description of the operational features of *HamComm*, refer to the HC.DOC file provided with the evaluation copy of *HamComm*.

This completes the checkout and alignment of the VR2. As a reward for all your hard work, this would be a good time for a RTTY ragchew—or perhaps a little DX to get a feel for how your new modem performs. Have fun!

Table 3
Changes to the *Terman93* ALLMODE.INI file (words in italics indicate values that vary among stations)

Heading	*Search for*	*New Setting*
[RTTY]	ReverseTX	ReverseTX=T*
	Reverse	Reverse=T
[AMTOR]	Selcall	Selcall=*your selcall***
	TXReverse	TXReverse=T
	Reverse	Reverse=T
[PACTOR]	Mycall	Mycall=*your call*
[LISTEN]	CheapPactor	CheapPactor=T†
[AN93]	ConvAdjust	ConvAdjust=*20* (initial setting, see text)
	ComAddr	ComAddr= *correct port address* (per Table 4)††

*When you initially download the ALLMODE.INI file, it contains no entry for the ReverseTX parameter. Use a text editor to insert "ReverseTX=T" on a new line immediately under the [RTTY] heading. (If this isn't done, *Terman93* will add the parameter automatically and set its value to F, which will cause your transmit polarity to be incorrect.)

**Selcalls are created from the first letter plus the last three letters of a call sign. For example, the selcall for K7SZL is KSZL; for W1AW, it's WWAW.

†This setting apparently reduces the processing load for slow (eg, 12-MHz '286) computers. You need CheapPactor=T if your computer crashes when entering the listen mode, or it gives a LOST INTS error. It seems to make no difference for '386 and faster computers.

††One beta tester had interrupt problems. They were empirically solved by adding another parameter "ComInt=4" on a new line immediately after the ComAddr line. Values for ComInt appear in Table 4.

Installing T93

Download the compressed file TERMAN93.ZIP from the Internet at **http://www.ife.ee.ethz.ch/~sailer/ham/ham.html#hfterm**. Inside is a folder named AN93 that contains four files: ALLMODE.INI, LICENSE.TXT, MANUAL.DOC and TERMAN93.EXE.

Extract the files to an appropriate directory (say, C:\AN93) of your 12 MHz '286 or faster computer. The initial file extraction can be performed from within a *Windows* 3.1, *Win95* or *Win-NT* environment, however, you should operate *Terman93* only in native DOS mode.

T93's documentation file, MANUAL.DOC, is a model of brevity. While it does provide the essential information to interface the modem to a host running T93, it is largely silent with respect to on-the-air operation of the program. I'll describe operation somewhat here, but for additional detail visit my Web site (see Note 5).

The ALLMODE.INI file contains a number of configuration parameters that must be tailored for your particular installation before you can operate. Make a backup file, then use your favorite text editor to make the changes shown in Table 3. Again, use the "search for" text to locate a parameter, then change it as shown. When you're finished, save the revised file with the same name as plain text and exit the text editor.

Confirm that VR2 is connected to your computer, radio and a power source. Execute T93 by typing TERMAN93 at the DOS prompt in the AN93 directory. The screen shown in Figure 4 should appear. If the program immediately terminates, it means that the address and interrupt parameters for the COM port are not set correctly. If that occurs, edit ALLMODE.INI to change the address for the COM port (ComAddr parameter) and its associated interrupt vector and try again. Once you have T93 up and running, set your receiver

audio to slightly below normal listening level, and observe the asterisk in the upper right hand corner of the T93 screen. It should be moving back and forth on either side of an exclamation point, indicating that T93 is receiving input from VR2.

If you have a frequency counter with a 10-second or longer measurement period, follow the instructions in Section 1.17 of the AN-93 file MANUAL.DOC. This procedure describes how to accurately set the clock-correction parameter (ConvAdjust) in the ALLMODE.INI file. The T93 documentation indicates that the parameter must be set within 30 ppm, however, on-the-air experiments on PACTOR suggest that significantly greater errors can be tolerated with no degradation of link performance. If you don't have access to a counter, the initial ConvAdjust setting of 20 will be good enough to establish a PACTOR link. If you have trouble with the link stalling after the first half dozen words or so, adjust the correction factor empirically until the link remains synchronized.

Operating T93

Take a moment to explore the contents of T93's screen. There are four windows: receive, transmit, monitor and status (lower right-hand corner). Each is self-explanatory, with the exception of the monitor window, which is only active in AMTOR or PACTOR modes. It shows raw data sent and received in a packet form as well as a number of cryptic codes that appear to have been implemented as software debugging aids.

In preparation for your initial QSO with T93, let's review the most frequently used function keys. The emphasis here is on RTTY and PACTOR, since AMTOR activity has declined to a negligible level. Important function keys include:

F2 Menu—Provides menu access to most of T93's functions including clock correction and emergency link down. The menu is generally not used during routine operations since it invariably requires multiple keystrokes to accom plish tasks that can otherwise be performed with a single function key.

F3 Over—Turns the link back to the other station when in PACTOR ARQ mode

F4 Lstn—Puts T93 in receive mode for PACTOR and/or AMTOR.

F5 PctFEC—Selects PACTOR FEC transmit mode (used for calling CQ).

F6 FEC—Selects AMTOR FEC transmit mode (used for calling CQ).

F7 RTTYrx—Selects RTTY receive mode

F8 RTTYtx—Selects RTTY transmit mode

Consider labeling your function keys with these functions prior to your first QSO.

RTTY

Table 4
ComAddr/ComInt Parameter Table

Port	*ComAddr*	*ComInt*
COM1	3F8H	4
COM2	2F8H	3
COM3	3E8H	4
COM4	2E8H	3

enter any text for several seconds, T93 will send a continuous stream of RY characters. (This feature can be disabled from within ALLMODE.INI if you wish.) When you start typing, the RYs cease, and your keyboard input is sent. Unlike *HamComm*, which has provisions for an end-of-buffer TR-control character, T93 is happy to terminate a transmission in midstream if you press **F7** before the transmit buffer is empty.

Monitor the progress of transmission by watching the receive window for transmitted characters (they're blue) to confirm that all the entered text has been sent before pressing **F7** to return to the receive mode. T93 does send text files that contain predefined brag tapes, CQs and so on. When this facility is used, a "\q" text-string terminator can be used to automatically switch back to receive mode at the end of the file. Unfortunately, an apparent program bug causes it to always return to the PACTOR receive mode, so an additional keystroke (**F7**) is required to reset T93 to RTTY receive. Because of this bug and T93's limited RTTY feature set, I prefer to use *HamComm* for RTTY work.

PACTOR

Press **F4** to place T93 in the PACTOR/AMTOR receive mode and tune to the lower part of your favorite digital band until you hear a PACTOR FEC transmission.[7] FEC mode is used almost exclusively to call CQ on PACTOR. Note the call of the station and press **ALT-P** to bring up the PACTOR menu; you will find that the selection Master Shortpath is already highlighted. If the station is domestic, press **ENTER**. A second menu then appears, requesting the call of the other station. Delete the default entry, "NOCALL," before you enter the call of the station sending CQ. When call entry is complete *and the other station has stopped calling CQ*, press **ENTER**. You will hear the TR relay pull in and your transceiver will begin transmitting and receiving. During the receive periods you should hear the other station respond, and after a few exchanges *your call* should appear (blue) in the receive window. This is your cue that a link has been established—start typing. Introduce yourself and turn the link over to the other op-

turn the contact over. Note the mixed use of upper and lower case characters—PACTOR supports both, and the backspace key even works!

To call CQ, press **F5** and your transceiver's TR relay will pull in. This places you in the PACTOR-FEC transmit mode. Enter your CQ text and monitor the progress of transmission until the contents of the buffer have been completely sent. Press **F4** to return to the PACTOR-receive mode. With luck, you will hear a reply. If so, quickly adjust your RIT to the calling station if necessary, but don't touch the keyboard. Within a few seconds, you will hear your transceiver automatically switch to transmit (in response to TR commands from your computer executing T93). When the link has been established, the call of the other station appears in the status window in the lower right-hand corner of T93's screen. The other operator will typically introduce him or herself and turn the link back to you. From that point on, simply use the **F3** key to turn the link around so that the other operator can transmit. This brief overview of T93 operations should get you started, but refer to the supplementary manual on my Web site (see Note 5) to learn the full capabilities of the program.

Conclusion

VolksRTTY II, *HamComm* and *Terman93* represent an economical approach to adding a relatively full-featured HF digital capability to your station. Excluding the PC board and enclosure, parts cost for the VR2 modem should not exceed $40. Best of all, the circuit is robust enough to be easily implemented by anyone who has successfully completed simple analog projects such as an audio filter or D-C receiver. Test-equipment requirements are limited to a VOM or DVM, although a frequency counter would be helpful.

Based on the correspondence I received following publication of the initial VolksRTTY article, I'd say many hams would find loading and configuring the software to be the most challenging element of the VR2 project. It's not that this aspect of the project is particularly complex, but rather many amateurs cannot comfortably create a subdirectory, copy, edit and save a text file under DOS.

If you experience "deer in the headlights" syndrome when faced with the DOS prompt (C:\), I recommend you obtain copies of *HamComm* and T93 before building the modem. Try installing them on your computer, and if you run into problems, contact computer-savvy friends for help. If you have none, solicit assistance from a club member or get on the local repeater

radio and establish a PACTOR link using a modem you built yourself, your efforts will all seem worthwhile.

One last comment—following my previous article I was flooded with "tech support" e-mail inquiries that consumed a significant fraction of my spare time for nearly two months. Although I will try to respond to questions on this project, please download the supplementary documentation from my Web site and check out the frequently-asked-questions (FAQ) files there before you send me your inquiry. Someone else has probably encountered the same problem and the information you need may already be available.

Good luck with the project, and I hope to work you on PACTOR in the very near future.

Notes

[1]T. Mayhan, K7SZL, "VolksRTTY II: for RTTY, AMTOR and PACTOR: Part 1," *QST*, Oct 1999, pp 41-44.

[2] A limited number of VR2 parts kits are available from the author for $80 each, plus $5 for US shipping ($10 for overseas). The kit includes main and display PC boards, all board-mounted components and interconnecting ribbon cable. Order from Terry Mayhan, K7SZL, 4517 159th AVE NE, Redmond, WA 98052; **tmayhan@worldnet.att.net**; **http://home.att.net/~k7szl/**.

[3]See Bill (KD7S) Jones's Web page at **http://www.psnw.com/~kd7s/elmer101.html** for details of building custom enclosures using scraps of ABS plastic.

[4]Ron Finger, W7ZT (a beta tester for this project), suggested RadioShack's P/N 270-253A as a suitable enclosure that is readily available.

[5]An evaluation copy of *HamComm* is available from a variety of ftp and Web sites including the author's "Unofficial *HamComm* Home Page," which is located at **http://home.att.net/~k7szl/**. A registered copy of *HamComm* is available for $30 from W. F. Schroeder (DL5YEC), Augsburger Weg 63, D-33102 Paderborn, Germany.

[6]**IMPORTANT**—the evaluation copy of *HamComm* will not run properly in a DOS window under Microsoft *Windows*. You must quit *Windows* and run/restart the computer in DOS mode.

[7]In my area, PACTOR activity is usually found on 3620—3630 kHz, 14,065—14,080 kHz and 21,065—21,080 kHz. If you aren't sure what PACTOR FEC sounds like, point your browser to my Web site (see Note 5 for URL).

Terry Mayhan, K7SZL, was first licensed in 1962 and currently holds an amateur Extra class license but no microphones. He received a BSEE from the University of Washington and an MSEE from the US Naval Postgraduate School in Monterey, California. Terry has held positions as a commissioned officer in the Navy, aerospace systems engineer and in technical marketing. He is presently employed as a product manager for an electronics company that develops communications equipment for police and fire dispatch centers. You can reach Terry at 4517 159th Ave NE, Redmond, WA 98052; ***tmayhan@worldnet.att.net***.

New Products

BEACONFINDER GUIDE TO LONGWAVE STATIONS IN NORTH AMERICA

◊ Many amateurs and shortwave radio listeners enjoy tuning the frequency spectrum just below the AM broadcast band—530 kHz and down. This region is filled with signals from navigation beacons, time stations, experimenters and numerous utility stations. Identifying these signals can be challenging, however, as they are not often listed in conventional frequency guides.

The *BeaconFinder* frequency guide focuses specifically on frequencies below 530 kHz. It lists the frequency, identification and location for hundreds of longwave broadcasters that can be heard in North America—including commonly logged foreign stations. An "ID-to-frequency" cross-reference section facilitates the identification of stations by either ID or frequency.

The guide consists of over 60 pages of listings punched for three-ring binding. A companion 3.5-inch diskette (in *.rtf* format) that contains searchable station listing is also available.

Price: *BeaconFinder* guide, $11.95 postpaid; *BeaconFinder* diskette, $11.95 ($8.95 when purchased along with the guide). For more information contact Kevin Carey, PO Box 56, West Bloomfield, NY 14585.

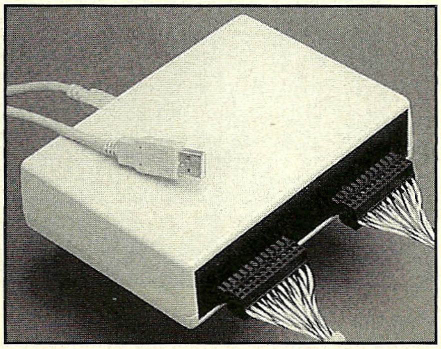
USB OPTO-ISOLATED INPUT/ OUTPUT MODULE FROM J-WORKS

◊ J-Works Inc, a developer and manufacturer of PC and USB-based test instrumentation and home automation products, now offers their JSB-320 series USB input/output modules.

This peripheral unit connects to your PC's USB port and can provide up to 32 opto-isolated inputs and outputs. The user can control these from any programming language that supports USB communications.

The outputs are rated at 7-30 V dc 1 A. The input range is 10 to 30 V. Plug-in style terminal blocks allow easy hook-up.

Price range for the JSB-320 series modules ranges from $205 to $299. For more information contact J-Works Inc, 12328 Gladstone Ave Unit 4, Sylmar, CA 91342; tel 818-361-0787; fax 818-270-2413; **sales@j-works.com**; **http://www.j-works.com**.



Strays

FREE SWEEPSTAKES SOFTWARE

◊ The *November Sweepstakes Logging Program*, version 2.5, by N3FJP is now available for free downloading from the Web. The program has been modified to accommodate the new precedence characters (S, M, U) and write the new Cabrillo file format for submission to the ARRL. You can download the software at **http://members.aol.com/snkdavis/page1.html**.

IF THE CALL SIGN FITS...

◊ The Amateur Radio career of Issac Roach, K4QM (SK), began in the early part of this century. In fact, he participated in the 1BCG transatlantic tests in 1923. Due to work and family responsibilities, however, he allowed his license to lapse in 1930. According to his son, Lloyd, W3QT, when Issac re-joined the hobby in 1965 he was astonished at his new call sign. And after 35 years what "Roach" wouldn't be surprised to learn that he had been assigned WA3*DDT!*

MOBILE WEB

◊ Brian, K2BJ, in Syracuse, New York has created a Web site devoted to HF mobile operating. The site features a display of ham license plates from the US and Canada. Brian is seeking contributions of plate images to fill out the collection. Visit the site at **http://www.k2bj.com.**

WANTED: FORDHAM SCHEMATIC

◊ I'm looking for the schematic for a Fordham 550-MHz frequency counter. Daniel V. Mackey, KC2DCX, 70 Candlewood Gardens, Baldwinsville, NY 13027-2634; **dmackey@arrl.net**.

WANTED: AMPSPEC-3 INFO

◊ I own an Ampspec-3 HF Spectrum Display Receiver from Mauro Engineering of Shasta, California. The one I have is for use with a Commodore 64 computer. They offered a version for IBM PCs and compatibles as well. I would like to hear from anyone who has made the conversion from a Commodore to a PC-based system. Larry Van Fossen, WB7UZO, PO Box 182, Neah Bay, WA 98357; **wb7uzo@olypen.com**.

WANTED: ULTRACOM-25 MANUAL

◊ I need a service manual or even a schematic diagram for an Unimetrics Ultracom-25. Robert E. Hilton, N9SJV, 5809 Heatherview, Fort Wayne, IN 46818.

I would like to get in touch with...

◊...hams who were Nuclear Weapons Specialists in the Air Force, possibly in the missile programs, to form a net. Al Alvareztorres, AA1DO, **albert13@home.com**.

◊...anyone who knew Leo H. Hyman, licensed as W8STY/XU8 on October 12, 1945, at Hangchow Airdrome. Jay S. Hyman, W2CSS, 1032 East 2nd St, Brooklyn, NY 11230; **w2css@arrl.net**.

◊...anyone who has a schematic diagram for a Alinco SR4 or SR4D repeater controller. Mine is in need of repair and detailed information is difficult to locate. Steve Turner, PO Box 74, Quinton, NJ 08072.